Astrophysics Research And Analysis

Study of Cosmic Ray H and He Isotopes

Completed Technology Project (2015 - 2016)

Project Introduction

This proposal requests a support for analysis and interpretation of H and He isotope data from the last Antarctic balloon flight of the Balloon-borne Experiment with a Superconducting Spectrometer (BESS-Polar II). The isotopes 2H and 3He in the cosmic radiation are mainly secondary products from the p-p and p-4He interactions of primary cosmic rays in the interstellar medium. Other reactions such as 4He - 4He and p-(Z > 3) contribute to a lesser extent to the production of 2H and 3He, as well as antiprotons. In the past most isotope measurements have been limited by statistics and mass resolution. BESS-Polar II flew for 24.5 days over Antarctica in 2007-2008. It recorded 4.7 billion events, about 5 times events collected with the prior BESS-Polar I. The BESS-Polar II data offer a unique opportunity to identify and precisely measure H and He isotopes over a wide rigidity range, ~ 0.5 GV to ~4 GV. The BESS instrument has many outstanding hardware features, which enable precise measurements of cosmic-ray H, He, and their isotopes, in addition to antiparticles. Its long-duration-balloon flight drastically reduced statistical uncertainties, and it provides the most precise measurements of H and He isotope fluxes and secondary-to-primary ratios. The unprecedented precision of BESS-Polar II measurements together with other cosmic-ray data, can strongly constrain propagation models and their parameters. It also facilitates a sensitive study of cosmic-ray time variations, which contribute to our understanding of local conditions in the Heliosphere as well as modeling of particle fluxes and plasma conditions in the near-Earth environment. The long duration of the BESS-Polar II flight and stability of its detectors enable the study of transient time variations of hydrogen and helium isotope fluxes. Measurements of 2H and 3He isotopes along with their main parents 1H and 4He provide important information on both the Galactic and heliospheric propagation of cosmic rays, as well as a 'tracer' for antiproton calculations. Current propagation models will be evaluated using already reported antiproton/proton ratios together with the new 2H/1H and 3He/4He ratios. The proposed activities address NASA's 2010 Science Plan for SMD's Science Goals in Astrophysics and Heliophysics, specifically with the objectives to 'Understand the origin and destiny of the universe, and the nature of black holes, dark energy, dark matter, and gravity' and to 'Understand the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium'.

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

Astrophysics Research and Analysis

Project Management

Program Director:

Michael A Garcia

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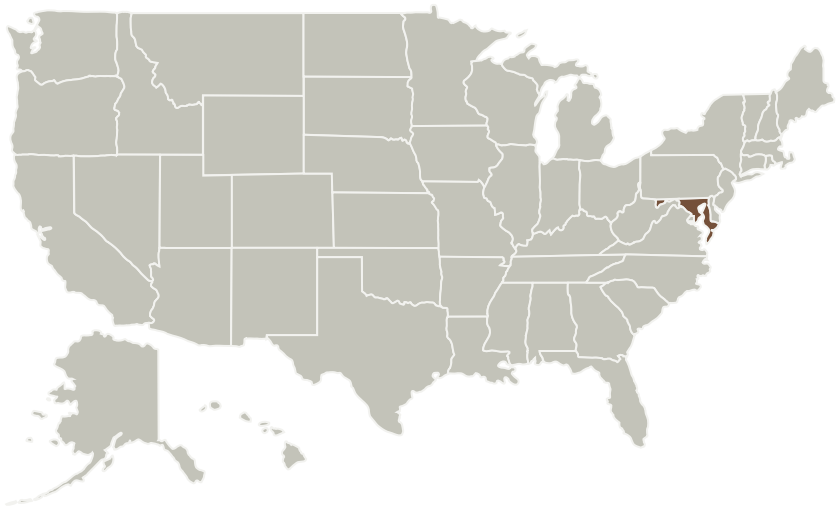
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Office of Research Administration & Advancement	Supporting Organization	Industry	
University of Maryland-College Park(UMCP)	Supporting Organization	Academia Asian American Native American Pacific Islander (AANAPISI)	College Park, Maryland

Primary U.S. Work Locations
Maryland

Project Management *(cont.)*

Program Manager:

Dominic J Benford

Principal Investigator:

Nicolas Picot-clemente

Co-Investigators:

Katie M Mckeon
Eun-suk Seo

Technology Areas

Primary:

- TX11 Software, Modeling, Simulation, and Information Processing
  - TX11.2 Modeling
    - TX11.2.4 Science Modeling

Target Destination

Outside the Solar System